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AUTHOR	Anooshian, Linda J.; Owens, Cornelius B.
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ABSTRACT

This study examines developmental differences in children's acquired knowledge of two routes of travel through an unfamiliar environmental area. Routes differed in terms of the extent of indirect travel required and were further differentiated in terms of direct and indirect segments of travel within each route. Each route connected four landmarks. It was expected that indirectness of routes would be especially problematic for young children because of frequent perspective changes. The children tested, 16 seven- and eight-year-olds and 16 ten- and eleven-year-olds, were taken from their school to an adjoining apartment complex area. Each child was led two times around a route and was instructed to study and remember the landmark next to that reference site. On the third walk around the route at each site the experimenter set up a telescope and asked the child to point the telescope in the direction of the three other landmarks. A four-way analysis of variance (age group by route by preceding segment by type of pointing) revealed a significant interaction between age group, route, and nature of the preceding route segment. Older children seemed better able to handle perspective changes of indirect routes than younger children. Younger females had difficulty when pointing to the same landmark from difference reference sites, but only if they walked the route which included the longer, indirect segment. Implications of the findings for understanding children's ability to represent relative spatial locations are indicated. (Author/RH)

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Children's Acquisition of Spatial Location Information in an Unfamiliar Environment

Linda J. Anooshian and Cornelius B. Owens

Trinity University

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Children's Acquisition of Spatial Location Information in an Unfamiliar Environment

Our basic interest in designing this research was in determining just how much children could learn about the locations of landmarks after limited exposure to a fairly large unfamiliar environmental area. We postulated that the greatest difficulties of young children in coming to know unfamiliar areas were a function of the complexity of routes of travel that are often encountered in exploring or traveling through those environments. In our study, we examined developmental differences for two routes that were used to familiarize children with an environmental area; the two routes differed in terms of the extent of indirect or circuitous travel which was required, with each route further differentiated in terms of direct and indirect segments of travel within each route. We anticipated that indirectness of routes should be especially problematic for young children because of frequent perspective changes--that is, changes in subject-landmark relationships with each turn in a route.

The children tested, 16 seven- and eight-year-olds, and 16 ten- and eleven-year-olds, were taken from their school to an adjoining apartment complex area. The apartment complex was such that different clusters of buildings surrounded pool and/or grass areas, with an extensive system of paths around and through the clusters. The two selected routes both followed existing paths in the apartment complex area. As shown in Figure 1, each route connected four landmarks. Route 1 (in dotted lines) was the shorter, and route 2 (shown in solid lines) had the longer indirect walks. Note that each route included alternating segments of direct and indirect walks. Thus, the two routes actually differed in terms of which pairs of landmarks

were connected by those direct and indirect route segments.

Each child was first led two times around the selected route (with half of the children tested with each route). The experimenter stopped at each reference site (marked with x's in Figure 1) and instructed the child to attend to, study, and remember the "special place" or landmark next to that reference site. Note from Figure 1 that reference sites (sites for stopping) were selected to be as close as possible to the corresponding landmark. The four landmarks included a coke machine, a large play-horse (for sitting and rocking), a dramatic point on top of a sauna building, and a large slide in the apartment complex pool.

When walking through the route a third time, the child and experimenter also stopped at each reference site. However, this time the experimenter set up a telescope and asked the child to point the telescope in the direction of three other landmarks (which, of course, were not visible from the reference site). Children could not see through the telescope, due to broken glass inside, but were asked to point it, just like they would point their finger if a friend asked them where something was. This procedure is similar to that used by Hardwick, McIntyre and Pick (1976) and avoids problems associated with assessing accuracy of environmental knowledge through such methods as map-drawing or model building. The direction (in degrees) of children's pointings was read directly from a compass attached to the telescope.

Mean errors (in degrees) for different types of pointings are shown in Table 1. Telescope pointing errors were differentiated in terms of pointings made immediately after the child had walked a direct route segment and errors made immediately after walking an indirect route segment. Within those groups, forward pointings were ones in which the child pointed

the telescope to the next landmark that would be encountered it the child continued on the route of travel. Backward refers to pointings to landmarks from which the child had just traveled. Inference pointings are those for which the child would pass an intervening landmark if traveling from the reference site to the landmark at which he was pointing; the term, spatial inference, is used here in the same way as discussed by Hazen, Lockman, and Pick (1978). The child would, for example, have to infer the direction from the sauna to the coke machine from previous experience in walking from the sauna to the slide and then from the slide to the coke machine.

Because higher error scores were associated with higher variances, a square-root transformation was applied to the data (the means for transformed scores appear in parenthesis in Table 1). A four-way analysis of variance (age group x route x preceding segment x type of pointing) revealed a significant interaction between age group, route (1 or 2, short or long), and nature of the preceding route segment (direct or indirect), $F(1,28) = 4.45$, $p < .05$. To examine that interaction further, the reader should refer to the columns labeled "overall" in Table 1; the appropriate means have been underlined to facilitate comparisons. Age differences were restricted to pointings following an indirect route segment for subjects walking route 1, and to pointings following a direct route segment for subjects walking route 2 (the longer route, with more extensive indirect segments). These results suggest that there are probably not qualitative differences between the two age groups. Rather, it appears that there are differences in the difficulty level at which we observed a drop-off in performance. Difficulty level is here defined in terms of the extensiveness or length of the route and whether the preceding route segment was direct or indirect. Basically, older children seem better able to handle the perspective changes involved in

indirect routes than do younger children.

Although the main effect for direction or type of pointing, or interactions with that factor, did not reach acceptable levels of significance, it should be noted that the magnitude of the age differences varied considerably across different directions of pointing (backward, forward, and inference pointings). The magnitude of age differences for backward pointings suggest that there may be large developmental differences in the ability to mentally reverse a route that has just been traveled. Young children did as well as older children if pointing backwards over a direct route segment (just traveled) in the shorter route. But, for other backward pointings, mean errors for the two age groups differed by 28 degrees or more.

Overall, in examining Table 1, it is apparent that mean absolute errors were fairly large for most of the pointings. We feel that the difficulty of the task may well have clouded further distinctions in accuracy levels for different types of pointings. Further analyses of the data were directed toward distinguishing between general- and specific-level representations, as discussed by Hardwick, McIntyre and Pick (1976). That is, it is possible that children pointed in basically the right directions, but that specific knowledge about direction was poor, with specific knowledge being especially disrupted by the requirement of keeping track of perspective changes in walking the routes. To explore this, an ordinal relationship score was obtained to reflect the degree to which children maintained the ordinal relationships among landmarks in their pointings. From a single reference site, children were given one point for each pair of pointings which maintained the correct ordinal relationship between landmarks.

As can be seen in Table 2, both age groups obtained high scores, with no apparent age differences. It is possible, however, that children obtained

high ordinal scores by simply remembering the temporal order in which landmarks were encountered on the route of travel, rather than actually remembering relative spatial locations or true configurational information (see Siegel & White, 1975). With this in mind, we also determined the number of pointings, for each child, which were correct in terms of both north-south and east-west directions. (For this score, we excluded the four pointings in which correct pointings would be especially close to the north-south and east-west axes, making our distinctions somewhat meaningless.) As seen in Table 2, both age groups obtained relatively high scores, with no age differences.

On the basis of these findings, we suggest that both age groups were able to derive reasonably good general representations of the spatial locations of landmarks in the unfamiliar environment. Age differences appeared to be in the specific-level representations, and in the degree to which that specific directional information could be derived from experience with indirect and circuitous routes. This conclusion may seem premature, in that we may be over-rating the performances of younger children in light of large absolute errors. However, we feel that there is support for our suggestion. First, Stea (1976) has discussed various studies in which children younger than those tested in this study found it easy to work with aerial photographs, thus demonstrating abilities which would seem to require at least a basic understanding of general representations of spatial location. Second, we found the same pattern of results in an earlier study for which absolute errors were substantially lower than those reported for this study. When these same children pointed to landmarks surrounding their neighborhood, significant age differences were found for absolute accuracy, but not for relative accuracy measures.

In a final analysis, we were interested in the degree to which children

were consistent in pointing to a landmark, from different reference sites, regardless of the accuracy of those pointings. To assess this consistency, pointings were plotted on a map of the apartment complex. Then, pointings were scored for the degree to which pointing lines to the same landmark, from different reference sites, merged and intersected. Children were assigned up to 4 points for pointings to each of the four landmarks. The maximum of four points was given if pointing lines (from three reference sites) formed a triangle with an area of less than 15 square meters; three points were assigned if pointing lines, from the three reference sites, converged to make a larger triangle. If no triangle was formed, children were given 1 point for a single intersection and 2 points for two independent intersections.

In analyzing and interpreting these data, a main effect for age group, $F(1,24) = 5.72$, $p < .05$, was interpreted in the context of a significant interaction between age group, sex and route (1 or 2), $F(1,24) = 5.72$, $p < .05$. The greatest age difference, and the only one which was significant, was for females who walked the longer of the two routes (see Table 3). It appears that the younger females had difficulty when pointing to the same landmark from different reference sites, but only if they walked the route which included the longer indirect segments. This result was somewhat unexpected in that reports of sex differences in environmental mapping studies have not been frequent. However, in many other studies, the emphasis has been on the content or static aspects of environmental mapping. In this regard, Harris (1977) reports that, for small-scale spatial tasks, sex differences are most evident for tasks which require kinetic imagery abilities. We suggest that our task, with extensive perspective changes, requiring mental manipulation of environmental maps, stressed these kinds of kinetic imagery abilities more

than have other tasks. Consistent with this analysis, it should be emphasized that sex differences were apparent for consistency of pointing from different reference sites, but there was no evidence for sex differences in any of the accuracy measures.

In summarizing the results and implications, we suggest that age differences in absolute accuracy reflect differing abilities in handling the perspective changes required to derive location information from indirect and circuitous routes through environmental areas. However, we further suggest that these age differences are in specific-level representations. Young children may be quite able to obtain general-level representations of the relative spatial locations of landmarks even after fairly limited exposure to an unfamiliar environment. It should be noted, however, that children in this study were instructed to learn the locations of the landmarks; it is possible that young children would not spontaneously derive such general representations. Finally, our results suggest that, if the dynamic manipulation of environmental maps is required, one might expect to find sex differences as consistently for large-scale as has been previously observed for small-scale spatial tasks.

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Table 1

Mean Errors for Different Types of Pointings (Means Obtained After Square-Root Transformation Appear in Parentheses)

Group	Pointings preceded by direct walk				Pointings preceded by indirect walk			
	Forward	Backward	Inference	Overall	Forward	Backward	Inference	Overall
Route 1 (short)								
Young	36.38 (6.02)	31.44 (5.31)	33.31 (5.06)	33.88 (5.46)	58.25 (7.16)	53.75 (6.76)	48.56 (6.74)	53.52 (6.89)
Old	40.38 (5.79)	27.06 (4.90)	20.76 (4.31)	29.40 (5.00)	17.38 (3.87)	25.31 (4.80)	40.56 (6.13)	27.75 (4.94)
Route 2 (long)								
Young	57.13 (7.32)	49.38 (6.39)	48.63 (6.80)	51.71 (6.84)	50.75 (6.67)	58.56 (6.94)	49.56 (6.12)	52.96 (6.58)
Old	43.69 (6.49)	18.06 (4.08)	36.00 (5.69)	32.58 (5.42)	64.50 (7.42)	28.63 (5.27)	42.63 (6.41)	45.25 (6.36)

Table 2

Means for Absolute Error, Ordinal Relations, and Number of Pointings in Correct N-S and E-W Directions

Age group	Absolute error	Ordinal relations*	Directional scores**
Young	48.02	8.69	4.95
Old	33.74	9.25	5.44

*Maximum score of 12 possible.

**Maximum score of 8 possible.

Table 3

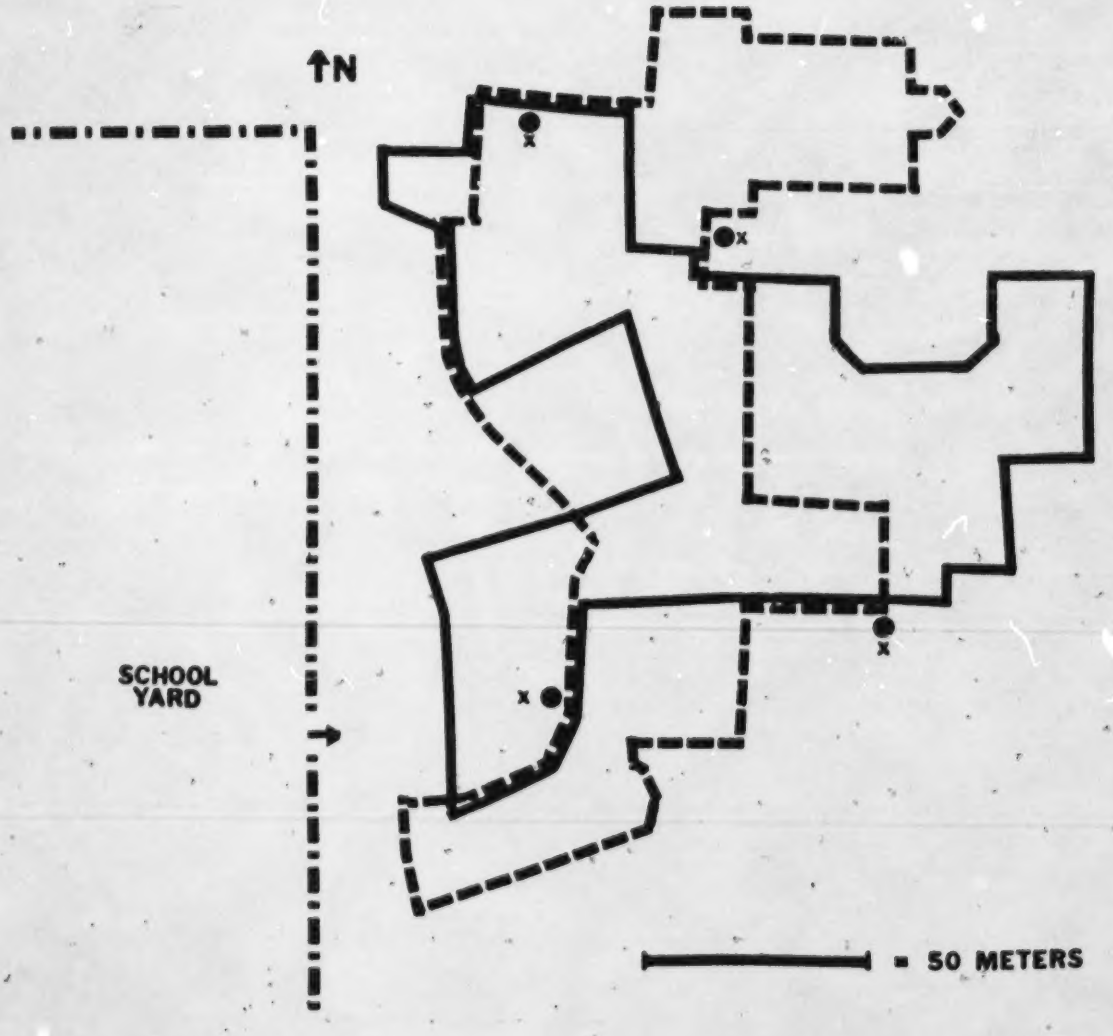
Mean Point Consistency Scores

	Route	
Group[a]	1--shorter	2--longer
Young		
Male	7.75	7.25
Female	5.25	3.00
Old		
Male	10.50	5.75
Female	6.75	9.00

[a]n = 8 per group.

Figure Caption

Figure 1. Map of the apartment complex area with landmarks (small dots), reference sites (marked with X's), walking route 1 (dotted lines) and route 2 (solid lines), and the entrance from the school yard.


N
SCHOOL YARD
= 50 METERS